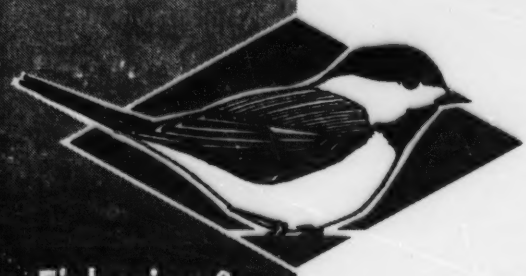

Fisheries & Wildlife Management Division

RESOURCE STATUS AND ASSESSMENT BRANCH

Harlequin Duck Surveys of the Oldman River Basin in 2000

Alberta Species at Risk Report No. 20

Alberta

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Harlequin Duck Surveys of the Oldman River Basin

Dale Paton

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EXECUTIVE SUMMARY

Aerial surveys by helicopters have been used in a number of areas in Northern Alberta (Gregoire 1999). This method is very useful in determining distribution of species such as Harlequin ducks, which can be sparsely distributed along inaccessible mountainous streams and are found across large geographic landscapes. Helicopters were found to be an effective and efficient method to survey 145 km of streams (total km of 2 surveys) in 6-7 hours. Surveys of this magnitude would take a number of years to accomplish by foot

The Oldman River Basin consists of the Oldman River drainage and the Castle River drainage. Previous instream foot surveys from 1997-2000 have gathered information regarding Harlequin duck breeding numbers and broods produced (Norstrom and Clark 1997, Norstrom and Clark 1998, Iwaasa and Taylor 2000). Helicopter surveys were flown along streams of the Oldman River Basin on May 17 and June 2, 2000. Helicopter survey methods consist of flying 10 meters over treetops along streams documenting the number of harlequin duck pairs, lone males and females and their locations. These data are compared to data from a ground survey to determine a visibility correction factor. The number of km flown was determined by measuring the distance from the first sighting of a Harlequin duck until the aerial survey stopped. End points of the surveys were determined by an inability to survey the stream (visibility poor due to obstruction of stream by trees) or arbitrarily when a length of stream did not contain any sightings of Harlequin ducks.

The May 17, 2000 survey found 36 ducks along 36.8 km of stream in the Oldman River drainage and 4 ducks along 45.7 km of river in the Castle River drainage. Using the mean visibility correction factor of 78.5 percent (n=2), a minimum population of 45.9 ducks for the Oldman River drainage and 4.1 for the Castle River drainage was calculated. The total minimum population for the Oldman River Basin would be 50 Harlequin ducks. Aerial survey data suggests a staging area for Harlequin ducks occurs on the Oldman/Livingstone Rivers. These findings indicate the Oldman River is an important Harlequin duck stream in SW Alberta. The Castle River system appears to have few breeding Harlequin ducks, but it is not known whether this has always been the case and it is important to investigate if the population is declining, stable or increasing. Continued monitoring of the two drainage systems are recommended. Management recommendations include conducting aerial and foot surveys as well as radio telemetry to identify important sections of stream and habitat used by Harlequin ducks for nesting and brood rearing. Additional aerial and foot surveys for ducks are needed in the Castle drainage and for unsurveyed areas of the Front Ranges and Waterton National Park.

Important life history information needs to be collected to allow managers to adequately monitor Harlequin ducks. To effectively monitor Harlequin ducks of the Oldman River Basin there is a need for information regarding distribution, identifying preferred nesting areas, brood rearing areas, and to determine if the lack of ducks in the Castle River drainage is evidence of a declining, increasing or a stable population.

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1. INTRODUCTION

1.1 Harlequin duck ecology

Harlequin ducks (*Histrionicus histrionicus*) are small multi-colored ducks that nest along mountain streams and winter in coastal areas. They are the only seabird in North America to nest exclusively along mountain streams. In North America there are two populations of Harlequin ducks, one on the Atlantic coast and one on the Pacific coast. The Atlantic population was classified as "Endangered" and the Pacific population is showing signs of decline (Robertson and Goudie 2000, Dunn and Sauer 1997). Throughout their range Harlequin ducks appear to be very selective of the stream they use, quite frequently returning to the same stream reach each year (Wallen and Groves 1989). Research has not determined exactly why these ducks are attracted to certain streams or even why certain reaches of the streams are preferred. The general habitat requirements for Harlequin ducks are:

1. clean fast-flowing water with cobble and boulder substrate;
2. instream nesting sites of woody debris, gravel bars and boulders;
3. undisturbed and intact drainages;
4. streams from 2-10 meters in width characterized by an abundance of riffle and rapid habitat, with a gradient of 1-7 percent.
5. dense shrub with numerous mature trees along stream banks;
6. a high biomass of benthic macroinvertebrates (Bengston and Ulfstrand 1972, Hunt 1994, Clarkson 1994).

Areas of lake outlet or inlet streams are occasionally used by Harlequin ducks. Lake environments are usually subalpine, clear, with good shoreline cover (Hunt and Clarkson 1993).

The majority of the Harlequin ducks are distributed throughout their range in areas with limited human access (Smith and Clarkson 1995). High levels of instream activities such as rafting, boating, fishing or use which concentrates people on shorelines have had negative effects on these ducks (Holroyd and Gartshore 1978, Clarkson 1992, Hunt 1998). Jasper National Park restricted raft float trips on Maligne River due to excessive disturbance of ducks and in Yellowstone National Park a popular viewpoint for fish viewing along the Yellowstone River was closed because Harlequin ducks quit feeding in the area. Studies indicate critical nesting and early brood-rearing sites are found in relatively undisturbed areas with little human activity (Wallen and Groves 1988, Breault and Savard 1991, Smith 2000). Harlequin nests are well hidden on the ground and usually near a stream, although a small number of sites have been found greater than 50 meters away from the stream edge (Bruner 1997, MacCallum and Bugera 1998, Smith 2000). Only rarely have nests been found in tree cavities (n = 2) and once in a rock cavity (Cassirer et al. 1993). Recent research has determined some Harlequin ducks will reuse nests or nest in the same general location in subsequent years (Smith 1996). Brood-rearing and nesting habitat are the least understood components of Harlequin duck ecology and are very important limiting factors for their distribution (Cassier and Groves 1991). Fledglings usually do not return to nest for two years and females in Montana

were not successful in raising two young until they were at least 4 or 5 years old (Reichel et al. 1997). The capacity to raise two young is significant, because a female must contribute 2 ducks (that reach breeding age) in her lifetime to maintain the present population of Harlequin ducks. If a nest failure does occur there is rarely a possibility of renesting for the male migrates back to the coast about the time incubation starts (Goudie et al. 1999). Harlequin duck winter distribution is along the western and eastern shores of North America and breeding is in mountainous regions (Fig. 1). Harlequin ducks are listed, as "Yellow A" in Alberta, meaning there have been concerns expressed regarding declining populations and productivity.

Figure 1. Harlequin duck distribution in North America.

1.2 Summary of Harlequin duck surveys in the Oldman River Basin

In 1997, the Alberta Environment Natural Resources Service initiated surveys for Harlequin ducks. Portions of the Carbondale River/ Lynx Creek and the Oldman/Livingstone Rivers were surveyed by instream foot surveys for spring breeding ducks and in August for broods. The survey boundaries and methods are outlined in Norstrom and Clark (1997) and Iwaasa and Taylor (2000). The results of all surveys are tabulated in Tables 1 and 2.

Table 1. **Harlequin duck instream survey data for 1997- 2000**

Stream	Year	# of Females	# of Males	# of young	Total ducks	Season
Carbondale River	1997	U*	U*	0	3	S
Lynx Creek	1997	U*	U*	0	2	S
Castle River	1997	U*	U*	0	0	S
1997 Total				**0**	**5**	S
Carbondale River	1998	0	1	0	1	S
Lynx Creek	1998	5	3	0	8	S
Carbondale River	1998	0	0	0	0	S
1998 Total		**5**	**4**	**0**	**9**	S
Oldman/Livingstone [1]	2000	17	19	0	36	S
Lynx Creek/Carbondale [1]	2000	2	2	0	4	S
2000 Total		**19**	**21**	**0**	**40**	S

S - Spring prenesting survey

U- Unknown

* - data not collected

[1] - Aerial survey

No spring prebreeding surveys were completed in 1999.

Table 2. **Harlequin duck instream survey data for 1997- 2000**

Stream	Year	# of Females	# of Males	# of young	Total ducks	Season
Carbondale River	1997	1	0	4	5	B
Lynx Creek	1997	0	0	0	0	B
Castle River	1997	0	0	0	0	B
1997 Total		**1**	**0**	**4**	**5**	B
Lynx Creek	1998	2	0	8	10	B
Oldman/Livingstone	1998	10	1	21	32	B
1998 Total		**12**	**1**	**29**	**42**	B
Oldman/Livingstone	1999	10	0	32	42	B
1999 Total		**10**	**0**	**32**	**42**	B
Oldman/Livingstone	2000	6	0	23	29	B
Lynx Creek/Carbondale	2000	3	0	11	18	B
2000 Total		**9**	**0**	**34**	**47**	B

B- Brood survey

No brood surveys were conducted along the Castle/Carbondale rivers during 1998.

2. STUDY AREA AND OBJECTIVES

Since 1997, foot surveys have been conducted along two waterways, the Carbondale River/Lynx Creek and the Oldman/Livingstone River systems (Norstrom and Clark 1997, Norstrom and Clark 1998). Foot surveys are effective in surveying small stretches of streams but it became evident that it would be too large a task to use this method to determine the status of Harlequin ducks within all of the Oldman River Basin. In an attempt to determine Harlequin duck numbers throughout the Oldman River Basin, helicopter surveys were flown along major streams and tributaries of the basin. The helicopter survey study area is approximately 3500 km^2 extending north to the Livingstone Falls on the Livingstone River, south to the Waterton National Park Boundary, with a western boundary of the Continental Divide and east to the Bow/Crow Forestry boundary. In this study, areas north of Highway 3 are considered the Oldman River drainage and those south of Highway 3 are the Castle River drainage (Fig.2). The basin is in the subalpine and montane ecoregions of southwestern Alberta. It consists of 2 drainages, the Oldman River drainage, (Livingstone River, Oldman River, Dutch Creek, Racehorse Creek) and the Castle River drainage (Carbondale River, west and south Castle Rivers, Lynx Creek, and Lost Creek) (Fig. 2). Helicopter surveys were focused on major streams of the basin (Fig. 2). Crowsnest River is located in the study area, but it was not surveyed. The Crowsnest River is the focus of a great deal of human activity and there have been no reports of Harlequin duck sightings from the public or Fish and Wildlife staff. Due to the lack of sightings all individuals involved felt the Crowsnest River was the stream least likely to have Harlequin ducks and if helicopter flying time were available, it would be the last stream to be surveyed.

Past instream foot surveys have documented observations of prenesting ducks during the spring and the number of females and ducklings during the summer. From these surveys and personal observations it was felt the Oldman River likely had the greatest number of ducks of all streams in the Oldman River Basin. The objectives of this study were to;

- attempt to determine sites of Harlequin duck concentrations on streams during the spring (staging areas);
- test the effectiveness of helicopter surveys for Harlequin ducks in the Oldman River Basin;
- determine distribution of Harlequin ducks in the study area;
- provide a summary of all Harlequin duck surveys completed in the study area.

3. METHODS

Helicopter surveys were flown along portions of the major streams and tributaries of the Oldman River Basin. Previous foot and boat surveys by Natural Resource Services (NRS) and Harlequin duck sightings reported by the public were reviewed to stratify the study area into stretches of stream that were likely to have Harlequins. Timing of surveys was scheduled to coincide with the presumed staging period before the ducks moved to various sections of the streams to nest. It was very

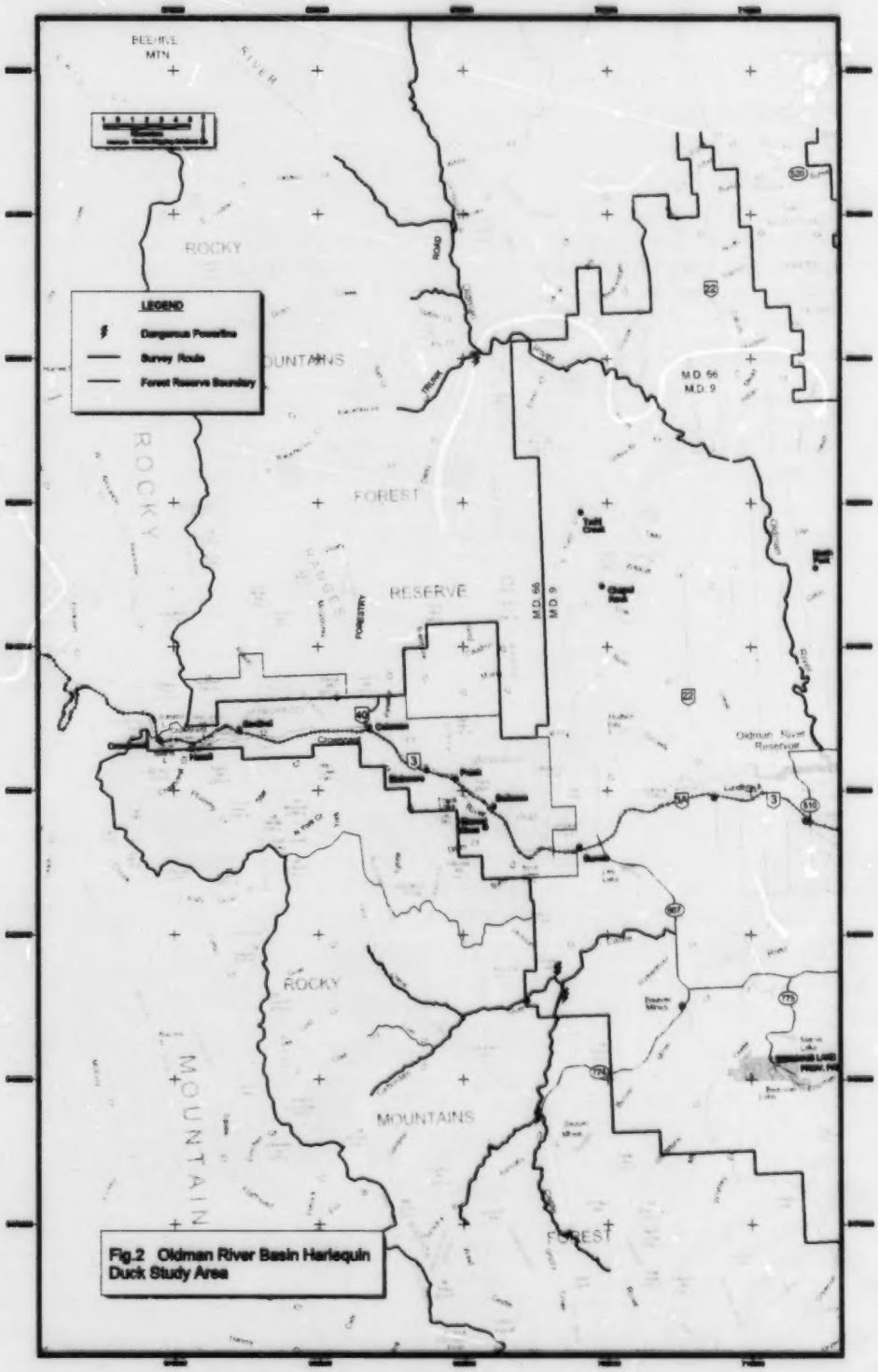

Fig.2 Oldman River Basin Harlequin Duck Study Area

important to conduct the surveys during this window of opportunity, for Harlequins are more visible and concentrated during staging times, providing an opportunity to count the maximum number of ducks.

A Bell 206 helicopter was contracted to conduct the surveys and the survey methods of Gregoire et al. (2000) were used to design the survey methodology. The observer/navigator was positioned in the front left helicopter seat with an observer/recorder positioned directly behind in the rear seat. Helicopter stream surveys were flown just above treetop at approximately 30 - 40 meters at an average speed of 45 km/hr. Streams were flown upstream or downstream until the stream became too narrow and meandering or visibility was obstructed by vegetation. The helicopter flew directly over the stream, usually closer to the pilot streamside so observers would have a good view. The front observer scanned directly ahead and along the helicopter pilot side of the stream with the rear observer focusing on the left side and underneath the helicopter. Observations of Harlequin ducks and stop/start survey points were located by Global Positioning System (GPS) coordinates. Data sheets were filled out with locations, total number of ducks, number of paired ducks, single females or males and other observed wildlife. Summaries of these data are in Appendix A ,B, and C.

The first day of surveys occurred during the morning of May 17, 2000 along the Oldman River system, with the Castle drainage system surveyed in the afternoon of the same day. A second survey was flown on June 2, 2000 to determine if the number of Harlequin ducks increased or decreased. This would provide information for future survey years regarding the timing of the staging activities of Harlequin ducks, as well as provide a replicate to evaluate the effectiveness of survey techniques and accuracy of the visibility correction factor.

As was suggested by Gregoire et al. (2000), a ground survey was undertaken to establish a correction factor for helicopter visibility compared to the greater accuracy of ground surveys. The helicopter flew the 4 km stretch of the Oldman River known as the Gap (Oldman Falls to Station Creek), during the same time it was being surveyed by ground. In an attempt to eliminate double counting of birds any displacement of ducks by helicopter or ground crew was recorded. Gregoire et al. (2000) ground surveys differed from this survey because it occurred across the complete stream, involved Harlequin ducks that were banded, and took two days to complete. Due to available time and manpower ground surveys on the Oldman River were 4km, no ducks were banded and the ground survey took 2-3 hours. Aerial surveys often have a frequent bias, the underestimation of population densities (Polluck and Kendall 1987), thus these helicopter surveys will represent a minimum estimate of Harlequin duck densities.

Observers for the aerial surveys were Dale Paton, Richard Quinlan (1st survey), Jim Clark, Dale Paton (2nd survey) and pilot Jock M^{c}heel of Bighorn Helicopters. The pilot for the second survey was Bill Oestreich from Bighorn Helicopters. Jim Clark, Wayne Norstrum (1st survey), Paul Harper, Wayne Norstom, and Mike Rosedal (2nd survey) conducted the ground surveys.

4. RESULTS

4.1 Chronology of Harlequin Duck Use in the Oldman River Basin

Occasional visual surveys along the Gap section of the Oldman River, confluence of the Carbondale River and Lynx Creek provided data on the presence of Harlequin ducks.

Oldman River visual surveys (by Dale Paton)

May 2, 2000 -1 male Harlequin duck
May 5, 2000 - 3 males and 2 females at the Gap on the Oldman River.
May 11,2000 - 3 females and 6 males.

The Carbondale River/Lynx Creek visual surveys.

May 6, 2000 - no observations of ducks on either stream,
May 16, 2000 - one pair and a lone male at the confluence of the two rivers
May 16 - another pair was observed on Lynx Creek, 2 km upstream of the confluence with the Carbondale River.

Al Chomica of the Water Survey of Canada made the following observations of Harlequin ducks:
May 29, 2000 – 1 male and 1 pair at the Gap section of the Oldman River
June 21, 2000 – 1 female at Castle River Ranger Station
June 22, 2000 – 2 females at Gap on the Oldman River

Observations by NRS Fisheries Survey Crew (Dave Pehl, Jody Fisher)
June 12, 2000 – 1 pair at junction of Gardiner Creek and Carbondale River
July 19, 2000 - 2 ducks on the South Caste River near Grizzly Creek

4.2 May Survey

On May 17, 2000, the helicopter aerial survey found 40 Harlequin ducks (GPS locations in Appendix A) over a distance of 82.5 km of river in the Oldman River Basin. Ten stretches of river were flown: 4 are found in the Oldman River drainage system and 6 occurred in the Castle River drainage system (Fig. 2). The numbers of ducks are highest in the Oldman River drainage with 36 ducks observed (Table 3 and Fig. 3) resulting in a relative abundance of 0.42 pairs/km and 0.88 ducks/km. Castle River drainage had 4 ducks (Fig. 4), which translates into a relative abundance of .07 pairs/km and 0.4 ducks/km.

We observed 19 female and 21 males from the helicopter for an overall percentage of 47.5 percent female (F) and 52.5 percent males (M) for a sex ratio of 1.1M:1F. All incidental observations of wildlife observed during the survey were documented (Appendix B). An exploratory helicopter survey of the section of river from the Oldman River Reservoir upstream to the Oldman River Falls did not find any Harlequin ducks. Few ducks if any were expected on the lower portion of the

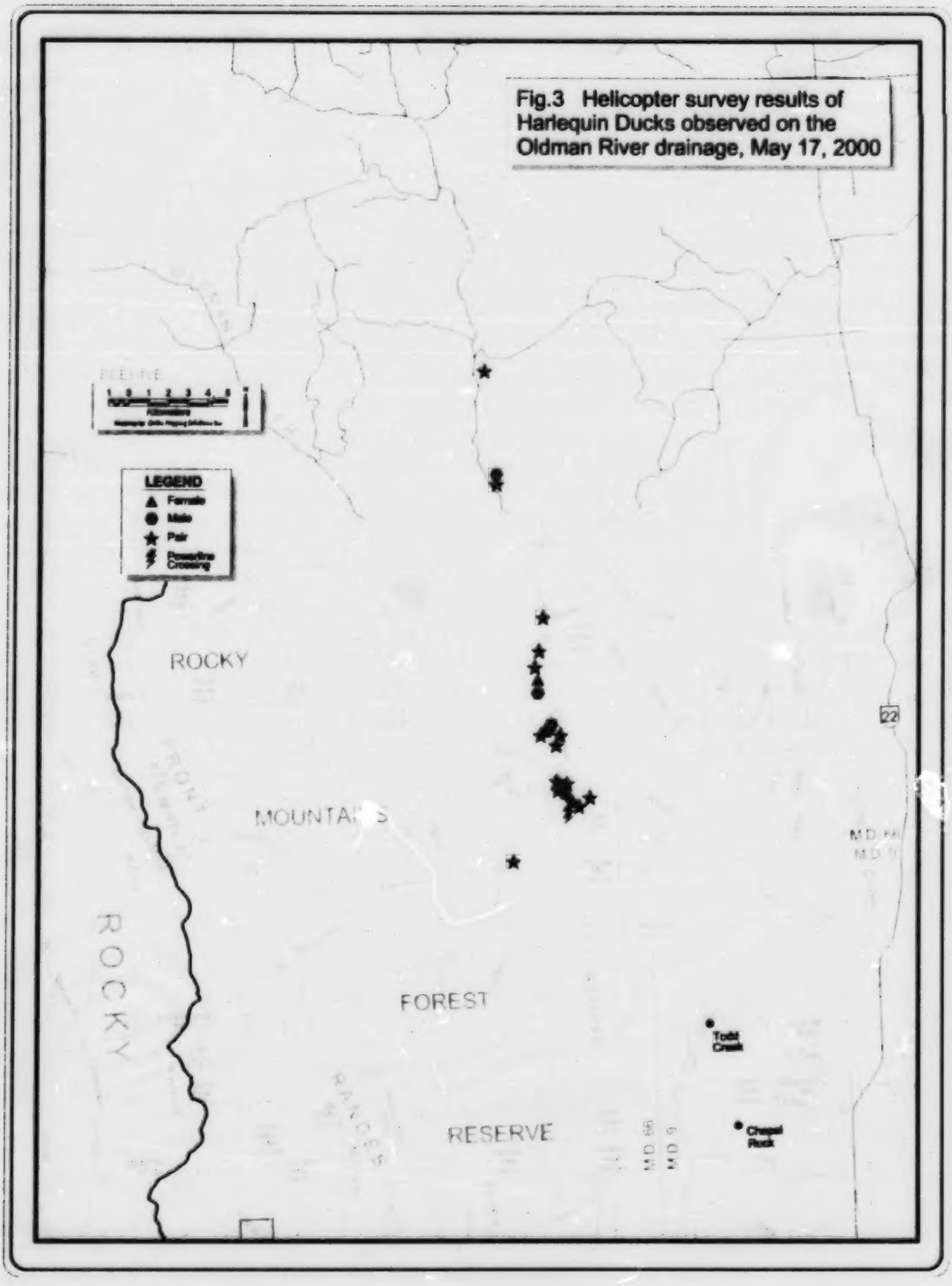

Fig.3 Helicopter survey results of Harlequin Ducks observed on the Oldman River drainage, May 17, 2000

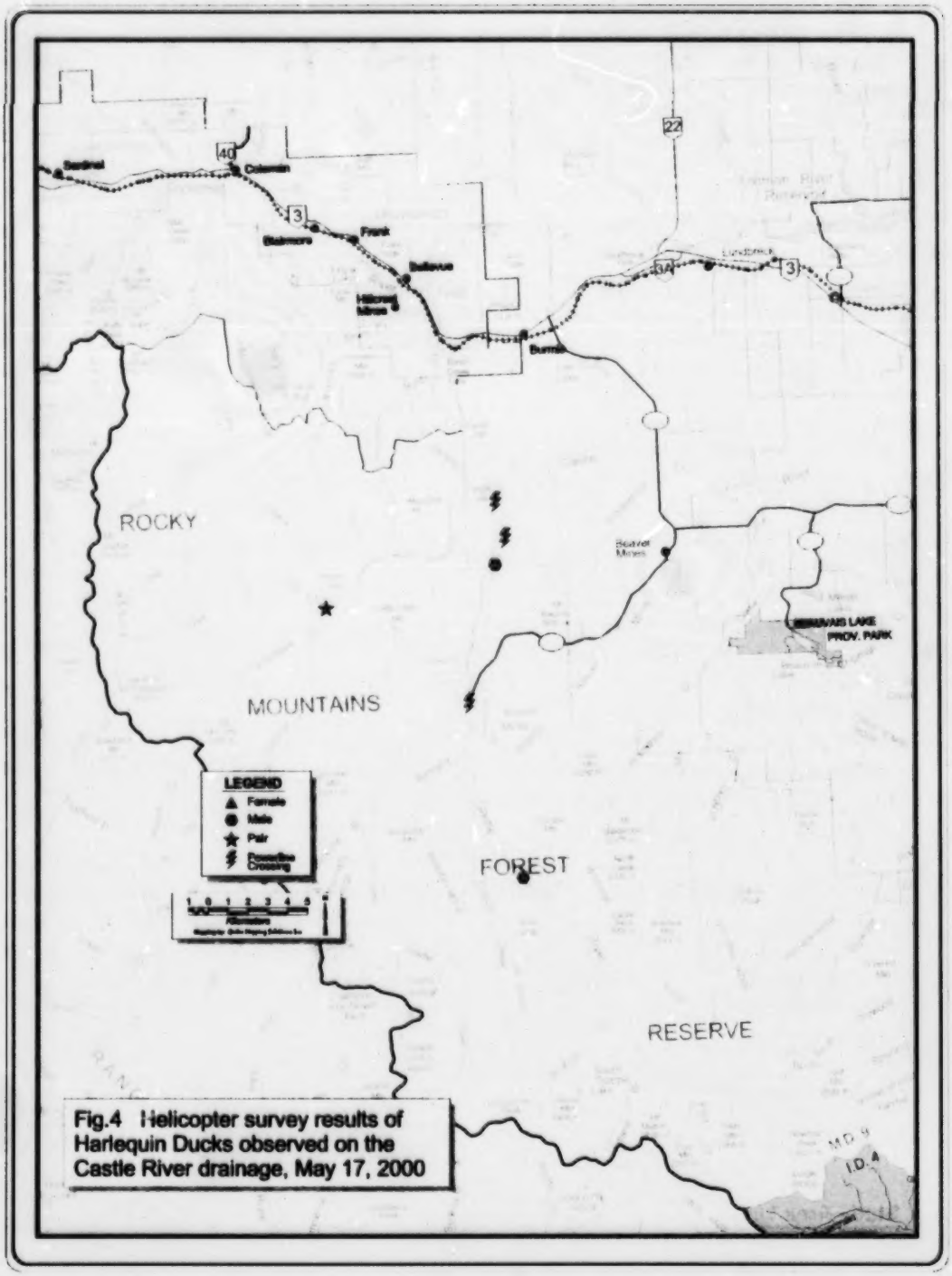

Fig.4 Helicopter survey results of Harlequin Ducks observed on the Castle River drainage, May 17, 2000

Oldman River due to a lack of stream characteristics desired by Harlequin ducks. The survey verified assumptions that there were not Harleqiun ducks present in the lower portion of the Oldman River. This section of Oldman River had many power lines crossing the river and is considered quite hazardous for low-level flying. It is recommended the lower Oldman not be surveyed again due to the power line hazards and absence of ducks.

May 17 ground surveys along 4 km of the Oldman River found 16 Harlequin ducks of which 11 were male and 5 were female. A same day aerial survey over the same 4 km stretch of river on May 17, found 13 Harlequin ducks comprised of 6 females and 7 males. We calculated a visibility correction of 81 percent by comparing the number of ducks observed on the ground survey with the number observed from the helicopter over the same stretch of river.

Table 3. May 17, 2000 survey results of the numbers and densities of Harlequin ducks observed in selected streams of the Oldman River Basin

Stream	Km Flown	#Pairs	Single Females	Single Males	Total	Pairs/km	Ducks/km
Oldman River drainage							
Oldman River	17.4	11	2	3	27	0.63	1.55
Livingstone River	15.4	3	0	1	7	0.19	0.45
Dutch Creek	2	0	0	0	0	0	0
Racehorse Creek	2	1	0	0	2	0.5	1
Subtotal	36.8	15	2	4	36	0.42	0.88
Estimate* for Oldman		(19.1)			(45.9)		
Castle River drainage	13.9	1	0	0	2	0.07	0.14
Lynx Creek	2.7	0	0	0	0	0	0
Lost Creek	2.3	0	0	0	0	0	0
South Castle River	13.6	0	0	1	1	0	0.07
West Castle River	8	0	0	0	0	0	0
Castle River	5.2	0	1	0	1	0	0.19
Subtotal	0	1	1	1	4	0	
Estimate* for Castle		(1.3)			(4.1)		
Study Area Totals							
Total Observed	45.7	16	3	5	40	0.07	0.4
Total Population Estimate*		(20.1)			(50)		

*Population estimate using the 78% visibility correction factor

4.2 June Survey

The June survey observed 23 Harlequin ducks over a distance of 62.1 km of river in the Oldman River Basin (Table 4). This survey was along the Oldman River from the Oldman Falls in the Gap to the forks of the Livingstone/Oldman and 6 km up the Livingstone River. We found 8 females and 15 males (Fig. 5) (GPS locations Appendix C), which is 34.7 per cent females and 65.3 percent males for a ratio of 1.8M:1F. The highest numbers of ducks were again on the Oldman River, consisting of 4 pairs, 2 lone females, and 8 individual males for a total of 18 ducks (Table 4). The Oldman River drainage had a relative abundance of .24 pairs/km, and .9 ducks/km. All incidental observations of wildlife observed during the survey were tabulated (Appendix D)

A ground survey replicate of the May survey, from the Oldman Falls to Station Creek observed 18 ducks consisting of 5 pairs and 8 individual males. One of the male Harlequins flew upstream and may have been counted twice (surveyors comments). An aerial survey of the same stretch of river found 13 Harlequin ducks consisting of 9 males and 4 females. A visibility correction factor was calculated to be 72 percent. If a double counting of one Harlequin male did occur the visibility correction figure would be 76 percent. The 76 per cent visibility correction number was chosen because a single flying duck was not observed by upstream surveyors, suggesting it landed between the groups of surveyors, did not leave the 4 km survey area and was likely counted twice.

The second survey along reaches of the Castle drainage system only found Harlequin ducks (n = 4) in Lynx Creek (Fig. 6). Relative abundance of ducks for Lynx Creek was .37 pairs/km and 1.11 ducks/km over a total distance of 2.7 km of stream. Portions of 6 streams located in the Castle drainage system were flown (Fig. 2) with 4 ducks observed over 45.5 km of stream. Relative abundance in the Castle drainage system was calculated as 0.02 pairs/km and 0.07 ducks/km (Table 2). We observed 2 females and 2 males along Lynx Creek for a ratio of 50 percent females to 50 percent males.

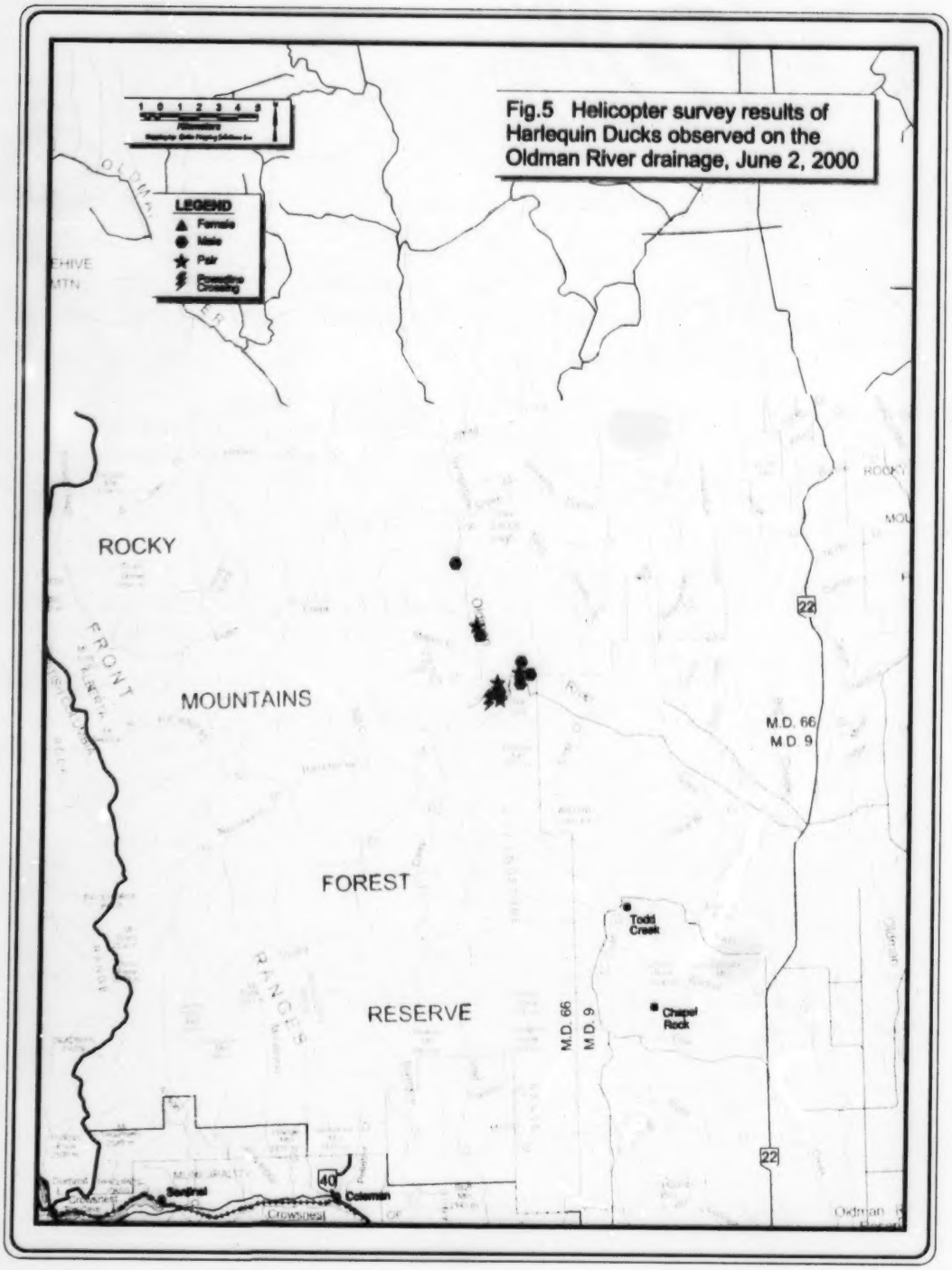

Fig.5 Helicopter survey results of Harlequin Ducks observed on the Oldman River drainage, June 2, 2000

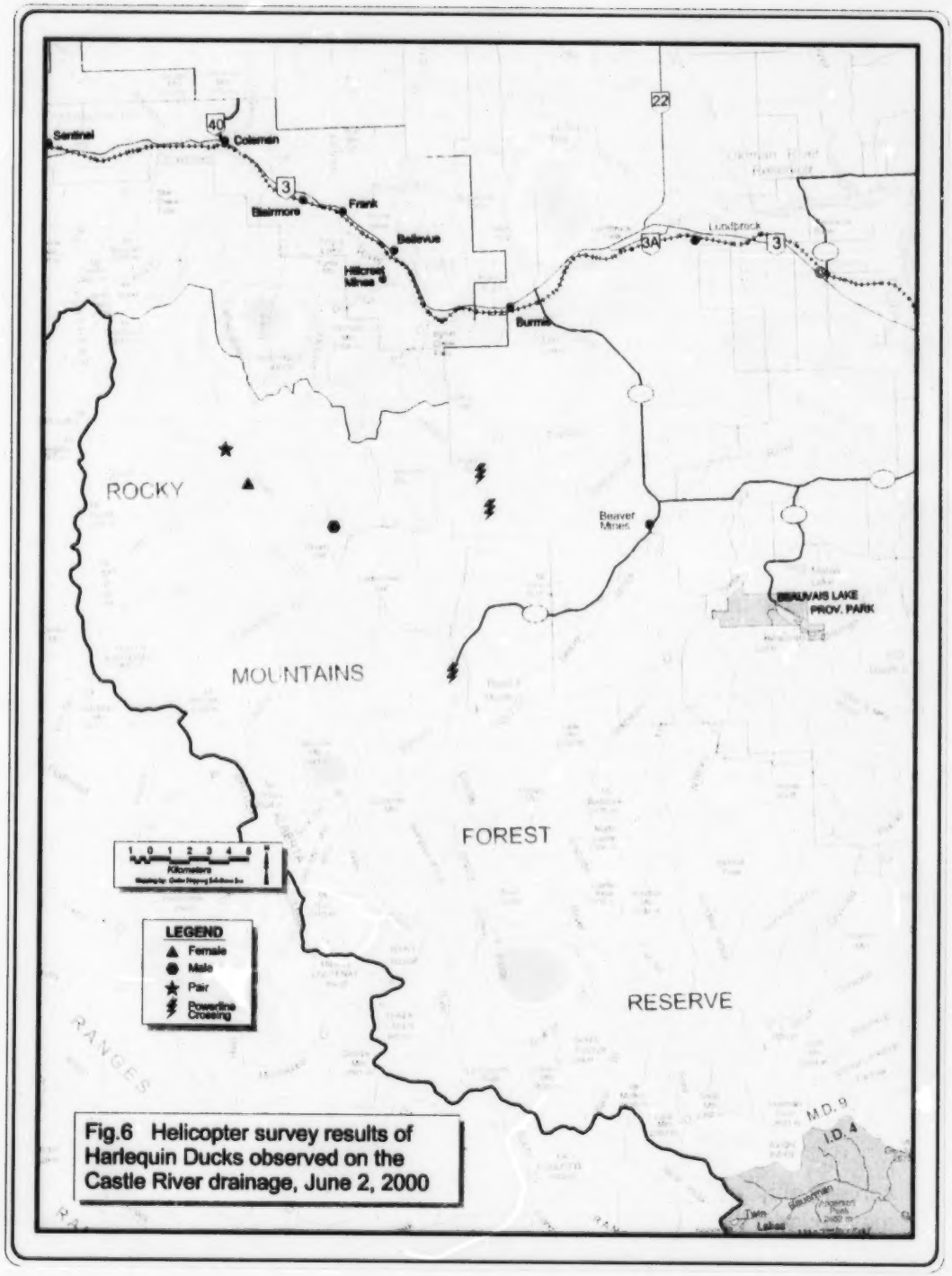

Fig.6 Helicopter survey results of Harlequin Ducks observed on the Castle River drainage, June 2, 2000

Table 4. June 2, 2000 survey results of the numbers and densities of Harlequin ducks in selected streams of the Oldman River Basin

Stream	Km Flown	Pairs	Single Females	Single Males	Total	Pairs/km	Ducks/km
Oldman River	10.6	4	2	8	14	0.38	1.32
Livingstone River	6	0	0	1	1	0	0.17
Dutch Creek	0	0	0	0	0	0	0
Racehorse Creek	0	0	0	0	0	0	0
Subtotal	**16.6**	**4**	**2**	**9**	**15**	**0.24**	**0.9**
Estimate* Oldman		**(5.1)**			**(19.1)**		
Carbondale River	13.9	0	0	0	0	0	0
Lynx Creek	2.7	1	1	1	3	0.37	1.11
Lost Creek	2.3	0	0	0	0	0	0
South Castle River	13.6	0	0	0	0	0	0
West Castle River	8	0	0	0	0	0	0
Castle River	5	0	0	0	0	0	0
Subtotal	**45.5**	**1**	**1**	**1**	**3**	**0.02**	**0.07**
Pop. Estimate* Castle		**(1.3)**			**(3.8)**		

(totals from Tables 1 and 2)

Study Area Totals	Pairs	Total
Total observed	**5**	**18**
Total Estimate *	**(6.4)**	**(22.9)**

*Population estimate using the 78% visibility correction factor

5. DISCUSSION

The use of helicopters is an effective and efficient method for surveying Harlequin ducks. To survey 82.5 km of river took 4 to 5 hours of flying time, in contrast brood surveys conducted by foot need a minimum of 5 or 6 people (up to 9 individuals) and 6 - 8 hours to survey 20 km of stream. Helicopter surveys allowed for many km of potential habitat in the Oldman River Basin to be surveyed. Many of the new reaches of stream surveyed were in the Castle River drainage system. In both aerial surveys only one male drake was observed in the newly surveyed streams. This may suggest the South Castle and West Castle may not provide adequate habitat or food for the Harlequin duck's specific habitat requirements. It is also possible flooding may have had an impact on populations consisting of a small number of breeding pairs. Studies in Montana seem to indicate that years with high peak runoff can depress brood production (Genter 1992). Combine this with random events such as a number of ducks dying or a number of reduced reproductive years caused by flooding, it could result in a dramatic reduction of a small population or even eliminate them (Hendricks and Reichel 1997). No baseline information exists for

Harlequin duck use of the Oldman River Drainage Basin, thus we are not able to determine if the lack of ducks in the Castle drainage system is an indication of a decline, the beginnings of a range expansion or a stable population. Of course the impact of flooding on Harlequin ducks in the Castle Drainage is only speculation for no data exists for this time period, yet it is important to discuss as another possible explanation for the low numbers. However due to natural variability in productivity and lack of long term data, further monitoring is needed before determining the possibility of a positive or negative population trend. Hunt (1989) suggested range expansion by Harlequin ducks is likely very difficult, due to a strong association of females to natal streams. There are likely few ducks available to pioneer new streams for site fidelity for breeding streams is high (probably exceeds 90%) for first time and experienced breeders, leaving few ducks available to explore and establish new breeding sites (Hendricks and Reichel 1997).

A review of published and unpublished literature indicates Harlequin ducks will choose to use some streams and not others. Researchers suggest it may be due to specific habitat requirements and insect prey availability but no one is sure which suite of requirements is critical (Wright el al. 2000). In Idaho, Cassirer and Groves (1991) noted low pair density streams were more accessible to human activity than streams with relatively higher pair densities. Recent research (Smith 1996) has found most Harlequin females show strong natal stream fidelity and will renest within a few meters of the previous years nest site. Harlequin ducks initiate egg laying just prior to and during peak spring runoff on streams (Smith 1996).

Aquatic insect production is very important to Harlequins and they may feed at the confluence of streams to take advantage of the two sources of food in one location (Smith 2000). Hunt (1998) found the quantity of aquatic invertebrates collected in the Maligne River varied significantly between the 3 years of study, but there was a significant positive correlation between the mean prey biomass index and the mean daily abundance of Harlequin ducks at the Maligne Lake outlet. Fisheries studies by Fitch collected aquatic insect data in the Castle River drainage system (J. Clark per com). It may be possible to use these data as a baseline to determine if aquatic invertebrate biomass changes have occurred in the Castle River drainage. A reduction in invertebrate numbers could be one reason why Harlequin ducks are found in low numbers in the Castle River drainage. Researchers in Oregon suggest Harlequin duck persistence and reproductive success in streams they studied is dependent on the availability macroinvertebates (Wright et al. 2000). Macro-invertebrate densities appear to be particularly important during breeding and brood rearing. Results from Wright et al. (2000) support the hypothesis of Bengston and Ulfstrand (1971) that prey availability influences Harlequin Duck reproductive effort. Radio telemetry research has found nesting Harlequin females traveling 13 km to feed (Smith 2000).

Harlequin ducks appear to prefer the Oldman River as a staging area. A total of 27 ducks were observed on 17.4 km of stream, which translates into a relative abundance of .63 pair/km and 1.55 ducks/km. This section of river represents the highest concentration of Harlequin ducks in the study area. One stretch of the Oldman River had 24 ducks in 10 km of stream for 2.4 ducks/km. The highest North

American Harlequin duck density was recorded in Banff National Park. Researchers found 6.2 ducks/km along a 15 km stretch of the Bow River (Smith 2000).

Harlequin ducks will congregate on staging areas; those females able to replenish body reserves move up adjacent tributaries or stay on the main stream to nest (Hunt 1998). Staging areas for the Oldman River drainage appears to be on the lower section of the Livingstone River and the Oldman River down to the Oldman River Falls where 86 percent of the birds were found on May 17, 2000. When the stretch was resurveyed on June 2 we observed 19 birds, nearly half were lone males, suggesting ducks had dispersed to other streams, possibly upstream, to nest along the tributaries and/or other sections of the Oldman river. Helicopter time for surveys was limited, so we did not survey to the headwaters of any of the streams. As well, Racehorse Creek and Dutch Creek are tight meandering streams with overhanging vegetation, making surveys very difficult. Surveys on the upper Oldman River ended 7 kilometers upstream of the Oldman/Livingstone confluence when ducks were no longer observed. The Livingstone River section of the survey ended approximately 12km from the same fork in the river.

Results from the May aerial surveys detected few ducks in the Castle drainage. The June set of aerial surveys focused our efforts in the Castle drainage, investigating the possibility that surveys were undertaken before staging had occurred. This does not seem to be the case and the same numbers of ducks were observed on the May 17 survey as were detected on the June 2 survey (Table 1 and 2). It is possible Harlequin ducks are staging in one of the Front Range tributaries to the east of the Castle River drainage or in the Waterton River. Sightings of ducks have been observed in many of these streams, particularly the Waterton River. If ducks are staging in these areas it is not known if birds later move to the Castle drainage. The only way to determine if movements between drainages are occurring would be to put colour-coded leg bands or radio telemetry on the Harlequin ducks.

The Castle drainage must be carefully surveyed and monitored to determine what actions managers need to take to insure Harlequin ducks do not decrease in numbers and that they have an opportunity to increase their numbers. Further searches of potential breeding streams are needed to determine distribution of Harlequin ducks in the Castle River drainage. Gathering of historical data will provide some insight into Harlequin duck use in the Castle River and Oldman River drainages.

In the Castle River drainage, Lynx Creek has consistently been a stream where observations of Harlequin ducks have been reported (Norstrom and Clark 1998, Iwaasa and Taylor 2000). May helicopter surveys did not find any ducks on the creek, but the June survey counted four birds (1 pair, 1 lone female, and 1 lone male). Subsequent brood surveys on Lynx Creek detected 2 females each with 5 young. To our knowledge, Lynx Creek is the most productive Harlequin duck breeding stream in the Castle River drainage system. Critical nesting and brood rearing habitat should be identified in Lynx Creek as well as the Carbondale River, where ducks have also been observed with broods (Norstrom and Clark 1997, Norstrom and Clark 1998).

Numerous studies describe duck densities as pair/km or ducks/km (Kuchel 1977, Cassier and Groves 1991, Gregoire 2000). The number of duck pairs located along a stretch of river may be an indicator of habitat quality, due to availability of necessary resources such as food or nesting habitat (Cassier and Groves 1991). Gregoire et al. (2000) indicated the limitations of the density of ducks per kilometer are a function of where the surveys initiated on the downstream stretch of rivers. This survey followed their recommendation to consider the point where the first duck was sited as the starting point of the Harlequin duck survey. They also suggested the surveys be completed to the headwaters. None of our surveys terminated at the headwaters for various reasons described previously, so our density figures represent the length of stream we surveyed. This coincided with a length of stream that did not have any duck observations for a reasonable distance. It became evident the majority of the ducks were on the staging areas and in all cases few if any appeared to have moved up the tributaries. Thus, our results would not be directly comparable to Gregoire et al. (1999) for the methodology varied a bit. Nonetheless, our data reflects the relative abundance of Harlequin ducks on the staging areas of the Oldman River Basin. Using duck data from helicopter surveys and the visibility factor, the minimum number of Harlequin ducks to be found in the Oldman River Basin would be 50 adult ducks (Table 2). The male/female sex ratio of Harlequin ducks was 1.1:1. These results are consistent with other Harlequin ducks surveys (Smith 1997 (1.1M:1F), Reichel et al. 1997 (1.54M:1F) ,MacCallum and Berga 1997 (1.6M:1F), Smith 2000(1.76M:1F)). Waterfowl populations are usually male-biased which is thought to be due to female mortality during the breeding season (Sargent and Raveling 1992).

6. CRITIQUE OF INVENTORY PROTOCOLS

With any technique there are usually areas where improvements may be made. The height at which the helicopter conducts the survey is very critical. At a height of 15m to possibly 25m Harlequin ducks will sometimes panic and fly away. On our second survey we were able to maintain our survey height and no ducks flew away. We observed the phenomena described by Gregoire et al. (1999), where ducks moved to the middle of the stream and dove into the water as an escape technique. This response facilitated the counting of birds and is suggested as a critical survey standard to maintain.

In May, the first aerial survey flew over the 4 km section of the ground survey at the same time the ground survey was being conducted. The May survey had a visibility of 81percent compared to the second aerial survey of 76 percent. The June helicopter survey was conducted 2 to 3 hours after the ground survey had been completed, so it is possible Harlequin ducks may have moved out the 4 km survey area affecting the overall visibility calculation. Future aerial surveys should occur over the section of river selected for a ground survey at the same time ground surveys are being walked. Visibility is better on cloudy days compared to sunny days, because less reflection occurs on the water during a cloudy day. When surveying the section of Oldman River located in the Gap, the sun was low and just breaking over the SE mountain ridge making observations of ducks extremely difficult. This stretch of river has a high concentration of Harlequin ducks, so it is recommended surveys occur later in the day or on cloudy days.

For instream foot surveys, it is recommended surveyors walk upstream, because disturbed Harlequins have a tendency to float downstream. In an unmarked population of ducks, upstream surveys reduce the chance of double counting. In the case of an aerial and ground survey being conducted simultaneously along a short survey section of river like the Gap section of the Oldman River, it would be a good practice to have the downstream person walk upstream and the upstream person walk downstream. With this method it would be possible to detect any movements of ducks such as flying upstream (possibly from disturbance by an approaching helicopter). It is suggested surveyors document the location of duck sightings on as map, duck activities (especially potential movements out of the survey area), stream characteristics, and adjacent habitat of the sighting, number of pairs, single males and females.

7. MANAGEMENT RECOMMENDATIONS

Helicopters have proven themselves an effective and economical technique to survey Harlequin ducks over a broad geographic scale in this and other surveys (Gregoire 1999). Aerial surveys documented in this report have gathered baseline data that can be used to help monitor Harlequin duck population trends in SW Alberta. It is recommended helicopter surveys occur in 2001 to verify the significance of the staging area on the Oldman River and search the streams of the Castle River drainage system, the Front Ranges (Pincher Creek, Drywood, and Yarrow Creeks), Waterton River and Waterton Lakes National Park. In the future, helicopter surveys of the Oldman River Basin should be an integral component of Harlequin duck monitoring; occurring every two to three years.

Color-coded leg bands on Harlequin ducks would provide information on population parameters (a population estimate, reproduction, survival, emigration and immigration information), which are needed to establish baseline data for a monitoring program of Harlequin duck populations in the Oldman River Basin. The importance of this technique is reflected in the wide spread use of leg banding in a majority of Harlequin duck monitoring programs (Cassirer and Conley 1995, Smith 1996, McCallum 1997, Ashley 1997 and Robertson 1999). A roadside survey with designated stop points is used to obtain observations of banded and unbanded birds. This information is used to calculate a population estimate, to determine areas of extensive stream use for breeding and brooding and the chronology of their use (Ashley 1997, McCallum 1999, Smith 2000). A Capture-Mark-Recapture /Resighting formula is used to determine a population estimate (McCallum 1997, Smith 2000)

Further life history information is needed to ensure Harlequin ducks continue to maintain and increase their population numbers in the Oldman River and Castle River Basins. Recent research has determined some female Harlequin ducks exhibit strong nest site fidelity and will reuse nesting areas in consecutive years (Smith 1996). Harlequin ducks do not breed until at least 2 to 3 years of age and on average only 20 to 30 percent (range of 7-55% in Montana, 20-28% in Kananaskis Country, Alberta) of the pairs are successful in raising young each year (Reichel et

al. 1997, Smith 2000) In Montana, Hendricks and Reichel (1998) have collected data which suggests an average female is probably at least 5 years of age before she has raised 2 female ducklings to fledgling age.

It is important to identify nesting areas so activities in these regions can be managed to reduce disturbance to the ducks during nesting and incubation. This is best accomplished by using radio telemetry to track females to their nesting sites. Radio telemetry methods will provide insights into nesting habitat, movements of adults and broods, as well as survival of adults and juveniles. Such critical life history information can only be collected in an efficient and sensitive way by using radio telemetry. Harlequin ducks do not utilize all stream bank habitats. This was observed in a study of Banff National Park (Smith 1996), where nesting female ducks were found not to be randomly distributed along the banks of the Bow River (Smith 2000). Nesting females exhibited a preference for certain sections of stream (Smith 2000). Criteria for nesting preferences have not been identified, but general stream habitat characteristics were a riffle habitat, rapids and pocket water, areas having a substrate of cobble and gravel (Smith 2000). Further monitoring of nest sites is needed to help predict potential nesting areas.

Instream surveys on the Oldman River and Carbondale River/Lynx Creek for breeding and brooding Harlequins should continue each year to monitor relative abundance of streams (ducks/km) on an annual basis. If instream surveys ever detect a significant downward trend over a number of years, helicopter surveys throughout the Oldman River Basin would help to verify the trend. Instream foot surveys each spring will determine the maximum number of ducks, particularly the number of females in the survey area and in the fall the number of females with young. This data could be used to determine productivity estimates. Productivity estimates of Harlequin ducks can be calculated by determining the number of class III young on the river relative to the maximum number of females counted in the spring (Nichols 1991, Smith 2000). Appendix E describes the methods used to categorize ducklings into various age classes. A late summer or early fall survey should be conducted to determine the number of class III young on the same section of stream as the spring surveys. A mid to late August survey for broods is the ideal time to conduct a brood survey for most females and ducklings will leave the nesting tributaries and be back on sections of stream which are richer in food. After mid August very little mortality of ducklings occurs so these numbers are the best means to estimate the number of ducklings surviving the summer and migrating to the coastal wintering grounds

Helicopter surveys in the Castle River drainage system failed to detect a staging area. In fact one may not exist. Yet, it would be beneficial to conduct aerial or foot surveys of the Front Range streams such as Pincher Creek , Yarrow, and Waterton River. Waterton Lakes National Park has a population of Harlequin ducks that may be linked with the Oldman River Basin birds. It is strongly recommended Waterton Lakes National Park be approached to partner in the management of Harlequin duck conservation. Current information suggests the core population of ducks found in streams south of Highway 3 is located in Waterton Lake National Park. Further helicopter surveys along the Front Ranges, areas near and in Waterton Park are essential to verifying this possibility. No information is available regarding Harlequin

ducks in the east Kootenays with few sightings in the region (Bob Forbes per com). There is a need to determine Harlequin duck distribution in the east Kootenays (Bob Forbes per com)

Standardization of surveys is very important and will allow comparison of data to determine Harlequin duck population trends. Future aerial and instream foot surveys should include the survey areas delineated in Iwaasa and Taylor (2000), walking upstream and documenting ducks observed in each reach of the stream.

Harlequin ducks have high adult survival combined with low productivity (Goudie 1994) which, combined with strong site fidelity on both the breeding (Smith 1996) and wintering grounds (Robertson et al. 1997), makes these ducks susceptible to unnoticed declines in populations. Population declines in such a long-lived species are likely only to be detected after many years of low recruitment (Pienkowski 1999, Crick et al. 1997). Low productivity may not be detected in a population of long-lived adults until the numbers of adults decreases, a number of years after the productivity decline (Smith 2000). Five years of monitoring Harlequin ducks in Banff National Park has determined the adult population of ducks is stable, but there is concern for declining productivity (Smith 2000). Such observations by researchers emphasize the need for management agencies to monitor Harlequin duck productivity.

Monitoring of the Oldman Basin population of Harlequin ducks would make a significant contribution to understanding to North American Harlequin duck distribution and ecology. The Oldman River Basin is one area of Harlequin duck breeding range where ducks could occur from a number of geographical areas (J. Ashley per com). Populations in Montana, Idaho, and Washington have been color banded with individuals from Washington detected at Lynx Creek this year. Appendix F contains information on leg band color codes used by North American studies for the pacific population of Harlequin ducks. In 1997, a banded female with young was observed during a brood survey (Nordstrom and Clark 1997).

Synopsis of Recommendations

1. Helicopter surveys should continue in the spring of 2001. Two seasons of data from aerial surveys are more reliable than one season. Conducting this study over multiple years strengthens our relative abundance minimum population estimates by yielding larger samples sizes. There is a need to verify the extent of the staging area on the Oldman River and aerial surveys would provide further information about the low numbers of Harlequin ducks observed in the Castle River drainage. Post 2001 aerial surveys should be flown every 2-3 years.

2. Instream surveys during the spring prenesting period (May 12-26) and summer brood surveys (August 15-30) should occur annually. To calculate production at least one survey per period (prenesting and brood) is needed to ensure the maximum numbers of ducks are observed.

3. Radio telemetry surveillance should occur on the Oldman River and the Carbondale River/Lynx Creek. This will provide critical information about timing of nesting, preferred areas of nesting habitat, as well as movements of Harlequin ducks to important stream habitats for brood rearing and feeding. Harlequin ducks have low reproductive capabilities, thus preferred areas for reproduction and brood rearing need to be identified to allow managers to maintain these sites from being lost and to prevent abandonment of the nest if excessively disturbed during egg laying and incubating.

4. Colour-coded leg bands should be put on Harlequin ducks of the Oldman River and Carbondale River/Lynx Creek populations. Banding combined with roadside surveys would collect data for a population estimate to be calculated. This would provide a baseline for future monitoring. A threshold needs to be established to determine when management actions are needed to maintain a population.

5. It is highly recommended Waterton Lakes National Park be approached to partner in the management of Harlequin duck conservation in SW. Alberta.

6. Historical information about Harlequin ducks needs to be gathered in an attempt to determine past distributions and breeding areas.

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Appendix A

GPS locations of Harlequin ducks observed on aerial survey of May 17,2000.

Appendix A

GPS Locations of Harlequin ducks observed on aerial survey of May 17,2000.

Oldman River

Species	Pair	Male	Female	#of HARD	Latitude	Longitude
Harlequin Duck	1			2	4952.062	11422.283
Harlequin Duck	1			2	4931.236	11359.77
Harlequin Duck	2	1		5	4931.236	11359.773
Harlequin Duck	1			2	4931.236	11359.773
Harlequin Duck	1			2	4932.258	11362.58
Harlequin Duck	1			2	4953.976	11423.141
Harlequin Duck	2	2	0	6	4953.976	11423.141
Harlequin Duck		1		1	4955.644	11423.679
Harlequin Duck	1		1	3	4955.644	11423.679
Harlequin Duck	1			2	4956.423	11423.488
Harlequin Duck	1			2	4956.873	11423.325
Harlequin Duck	1	1		3	5001.075	11425.063
Harlequin Duck	1			2	5003.87	11425.461
Harlequin Duck	1			2	4950.494	11424.852

Castle Drainage

Species	Pair	Male	Female	#of HARD	Latitude	Longitude
Harlequin Duck	1			2		
Harlequin Duck		1		1	4927.097	11419.113
Harlequin Duck				1	4918.514	11418.458

Appendix B

Incidental wildlife observed on May helicopter surveys of Harlequin ducks

Appendix B

Incidental wildlife observed on May helicopter surveys of Harlequin ducks

Oldman drainage

Species	Number observed	Survey Area
Canada Goose	78	Oldman Reservoir to Hwy 22 bridge
Canada Goose goslings	9	
Common Merganser	21	
Mallard Duck	26	Numerous sandpipers observed
Western Grebe	2	
Golden Eagle	1	
Ferruginous Hawk	1	
American Kestrel	1	
Red-tailed Hawk	1	

Species	Number observed	Survey Area
Canada Goose	74	Hwy 22 bridge to Livingstone/Oldman confluence
Canada Goose goslings	9	
Common Merganser	7	
Mallard Duck	13	
Blue-winged Teal	2	
Unidentified Eagle	1	
Prairie Falcon	1	
American Kestrel	2	
American Dipper	1	

Species	Number observed	Survey Area
Canada Goose	27	Confluence of Livingstone/Oldman to bridge 3km south of Livingstone Falls
Blue-winged Teal	11	
Common Merganser	6	
Dipper	1	

Castle River Drainage

Species	Number observed	Survey Area
Canada Goose	57	Beaver Mines Bridge to Lost Creek/Carbondale junction
Mallard Duck	5	
American Dipper	3	
Common Merganser	6	
Blue-wing Teal	2	
Mule Deer	1	

Species	Number observed	Survey Area
Canada Goose	26	West and South Castle Rivers
Canada Goose goslings	5	
Common Merganser	10	
Mallard Duck	7	
Blue-wing Teal	2	
American Dipper	1	
Golden Eagle	2	

Appendix C

GPS locations of Harlequin ducks observed
on aerial survey of June 2, 2000

Appendix C

GPS Locations of Harlequin ducks observed on aerial survey of June 2, 2000.

Oldman River

Species	Pair	Male	Female	#of HARD	Latitude	Longitude
Harlequin Duck	1	3		5	4952.66	11421.04
Harlequin Duck	1	1		3	4952.31	11427.55
Harlequin Duck		1		1	4951.93	11421.89
Harlequin Duck	2			4	4951.9	11422.02
Harlequin Duck		1		1	4955.55	11423.74
Harlequin Duck						

Castle Drainage

Harlequin Duck	1			2	4929.72	11429.71
Harlequin Duck			1	1	4928.74	11428.8
Harlequin Duck		1		1	4927.48	11425.25

Appendix D

Incidental wildlife observed on June helicopter surveys of Harlequin ducks

Appendix D

Incidental wildlife observed on June helicopter surveys of Harlequin ducks

Castle drainage

Species	Number observed	Survey Area
American Dipper	5	Carbondale R. confluence with Castle R. to Lost Ck
American Kestrel		
Red-tailed Hawk	1	
Sandpipers	18	

Species	Number observed	Survey Area
Canada Goose	10	Castle River, South Castle River and West Castle River
Canada Goose goslings	3	
Common Merganser	2	
Mallard Duck	1	
Red-tailed Hawk	1	
Sandpipers	31	
American Dipper	1	
Osprey	1	
Moose	1	

Oldman Drainage

Species	Number observed	Survey Area
Common Merganser	26	Oldman Falls to Oldman River/Livingstone confluence
Mallard Duck	4	
Kingfisher	1	
Sandpipers	5	
Red tailed Hawk	1	

Appendix E

Classification of various age classes of Harlequin ducklings

Appendix E

Class I. Downy, no feathers visible

Class II. Partly feathered

Class III. Fully feathered, flightless

Down

Feathers

CLASS I
Downy Young

a) Bright ball of fluff (1-7 days)
Colors bright. Patterns distinct. Body rounded; neck and tail not prominent.

b) Fading ball of fluff (8-14 days)
Brightness fading, patterns less distinct. Body still rounded; neck and tail are not yet prominent.

c) Gawky-downy (15-21 days)
Down color and patterns faded. Neck and tail becomes prominent. Body becomes long and oval.

CLASS II
Partly Feathered

a) First feathers (22-26 days)
First feathers show on side under ideal field conditions. Stays in this class until side view shows one-half of side and flank feathered.

b) Mostly feathered (27-39 days)
Side view shows half or more of side and flank feathered. Primaries break from sheaths. Stays in this class until side view shows down in one or two areas only (eg. nape, back, or upper rump).

c) Mostly feathered (40-46 days)
Almost fully feathered, with down on rump.

CLASS III
Fully Feathered

Feathered-flightless (>46 days)
No down visible. Primaries completely out of sheaths but not fully developed. Stays in this class until capable of flight. Wing and tail feathers very dark compared to female's.

Appendix F

Colour leg bands being used by researchers of Harlequin ducks

Appendix F

Colour leg bands being used by researchers of the pacific population of Harlequin ducks

Band colour	Code	Research Area
Red with white codes	Alpha/Alpha	Banff
Red with white codes	Numeric/Numeric	Kananaskis Country
Red with white codes	Alpha/Numeric	Jasper National Park
Red with white codes	Numeric/Alpha	McLeod River
Yellow with green codes	Alpha/Alpha	McLeod River
White with black codes		British Columbia
Green with white codes		British Columbia
Aqua with black codes		British Columbia
Black with white codes		British Columbia
Yellow with black codes		Washington State
Blue with white codes		Montana State
Pink with white codes		Idaho State
Grey with black codes		Oregon State
White with red codes		Oregon State
Pink with black codes		Oregon State

List of Titles in This Series
(as of July 2001)

No.1 Alberta species at risk program and projects 2000-2001, by Alberta Fisheries and Wildlife Division. 2001

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